

## 5. Ecological Exposure and Risk Characterization

### a. Evaluation of LOC exceedances

**Risk Quotients (RQs) and the Levels of Concern (LOCs).** In order to integrate exposure information with toxicity information, a risk quotient (RQ) is calculated by dividing exposure

$$\text{Risk Quotient} = \frac{\text{Exposure}}{\text{Toxicity}}$$

Examples of toxicity measurements used in the calculation of RQs are:

- LC<sub>50</sub> (fish and amphibians; birds)
- LD<sub>50</sub> (birds and mammals)
- EC<sub>50</sub> (aquatic plants and invertebrates)
- EC<sub>25</sub> (terrestrial plants)
- EC<sub>05</sub> or NOEC (endangered plants)

To assess whether there is an ecological concern, RQ values are compared to Levels of Concern (LOCs). The LOCs depend on whether the Toxicity measurement represents acute or chronic toxicity, and there are different LOCs for the acute RQs (see table below). The Agency interprets exceedances of LOCs as follows:

- *acute high risk* - potential for acute risk is high; regulatory action may be warranted in addition to restricted use classification;
- *acute restricted use* - the potential for acute risk is high, but this may be mitigated through restricted use classification;
- *acute endangered species* - the potential for acute risk to endangered species is high; regulatory action may be warranted;
- *chronic risk* - the potential for chronic risk is high; regulatory action may be warranted.

Currently, EFED has no procedures for assessing chronic risk to plants, acute or chronic risks to nontarget insects, or chronic risk from granular/bait formulations to mammalian or avian species.

### Levels of Concern (LOCs) for Assessing whether Risk Quotient indicates an ecological concern.

RISK PRESUMPTION	RISK QUOTIENT	LEVEL OF CONCERN
<b>Birds and Reptiles</b>		
Acute High Risk	$EEC^1/LC_{50}$ or $LD_{50}/\text{sqft}^2$ or $LD_{50}/\text{day}^3$	0.5
Acute Restricted Use	$EEC/LC_{50}$ or $LD_{50}/\text{sqft}$ or $LD_{50}/\text{day}$ (or $LD_{50} < 50 \text{ mg/kg}$ )	0.2
Acute Endangered Species	$EEC/LC_{50}$ or $LD_{50}/\text{sqft}$ or $LD_{50}/\text{day}$	0.1
Chronic Risk <sup>4</sup>	EEC/NOEC	1
<b>Wild Mammals</b>		
Acute High Risk	$EEC/LC_{50}$ or $LD_{50}/\text{sqft}$ or $LD_{50}/\text{day}$	0.5
Acute Restricted Use	$EEC/LC_{50}$ or $LD_{50}/\text{sqft}$ or $LD_{50}/\text{day}$ (or $LD_{50} < 50 \text{ mg/kg}$ )	0.2
Acute Endangered Species	$EEC/LC_{50}$ or $LD_{50}/\text{sqft}$ or $LD_{50}/\text{day}$	0.1
Chronic Risk <sup>4</sup>	EEC/NOEC	1

<sup>1</sup> abbreviation for Estimated Environmental Concentration; designated ppm in avian/mammalian food items

<sup>2</sup>  $\frac{\text{mg}/\text{ft}^2}{LD_{50} * \text{wt. of bird}}$     <sup>3</sup>  $\frac{\text{mg of toxicant consumed/day}}{LD_{50} * \text{wt. of bird}}$

<sup>4</sup> EFED does not have a standard approach for calculating chronic risk quotients for granular pesticides. Thus chronic risk quotients have not been calculated for phorate.

<b>Aquatic Animals</b>		
RISK PRESUMPTION	RISK QUOTIENT	LEVEL OF CONCERN
Acute High Risk	$EEC^1/LC_{50}$ or $EC_{50}$	0.5
Acute Restricted Use	$EEC/LC_{50}$ or $EC_{50}$	0.1
Acute Endangered Species	$EEC/LC_{50}$ or $EC_{50}$	0.05
Chronic Risk	EEC/MATC or NOEC	1

<sup>1</sup> abbreviation for Estimated Environmental Concentration; designated ppb/ppm in water

### (1) Terrestrial LOC evaluation

**Birds.** Birds may be exposed to granular pesticides by ingesting granules when foraging for food or grit. They also may be exposed by other routes, such as by walking on exposed granules or drinking water contaminated by granules. The number of lethal doses ( $LD_{50}$ s) that are available within one square foot immediately after application ( $LD_{50}\text{s}/\text{ft}^2$ ) is used as the risk quotient for granular/bait products. Risk quotients are calculated for three separate weight class of birds: 1000 g (e.g. waterfowl), 180 g (e.g. upland gamebird) and 50 g (e.g. songbird).

Consumption of granules depends on their availability, bird behavior, characteristics of grit/granules preferred by birds, and grit/granule retention in the gizzard (Best and Fischer, 1992).

Exposure of nontarget organisms, particularly birds, to pesticide granules is assumed to be related to the application rate and number of granules present on or near the soil surface. The quantity of pesticide near the ground surface after application, in a unit area -- typically, one square foot is used to estimate terrestrial exposure to pesticide granules. Support for this approach can be found in the literature. DeWitt (1966), after conducting a quail field study, concluded, "Losses of birds may be expected if the quantity of toxicant per square foot equals or exceeds the quantity causing deaths of quail in short term feeding tests."

All application methods for granular formulations will result in the presence of some granules at or near the soil surface, where they are accessible to foraging wildlife. Both band and in-furrow application of granular pesticides using conventional commercial application equipment may result in the occurrence of exposed granules on the soil surface. In a laboratory soil study using a variety of incorporation techniques and several models of planters operated at different speeds, Hummel (1983) found granule incorporation ranged from 69% to 96% for band application, and generally 99% for in-furrow application. Erbach and Tollefson (1983) found that an average of 15% of the granules remained visible when no incorporation other than a press wheel was used.

Tables below are percentages of applied granules assumed to be visible to birds for different application techniques. These percentages probably underestimate the actual fraction remaining because the information available is for granule counts within rows and does not represent row ends. The number of granules found in turn areas at row ends (where application equipment is raised from the soil) would be considerably higher than along row areas where granules are incorporated. Also, the fluorescent techniques used to observe granules were not 100% efficient, and thus did not allow the identification of all granules (Tollefson, 1979).

Percentage of pesticide granules remaining exposed after application (all crops)

APPLICATION METHODS	% UNINCORPORATED
Preplant broadcast	15
In-furrow, drill, shank	1
T-band or band (applied over emerged plants, incorporated, or in front of the press wheel)	15
Post-plant/at-cultivation (band)	15

The acute risk quotients for broadcast applications with no incorporation of granular products are tabulated below.

Avian Risk Quotients for Granular Products (Broadcast , No Incorporation)				
Site/Method Lbs (ai/A)	%(decimal) of Unincorporated Pesticide	Body Weight (g)	LD <sub>50</sub> (mg/kg)	Acute RQ <sup>1</sup> (LD <sub>50</sub> /ft <sup>2</sup> )
Corn and Hops				
3	1.0	50	1.0	624.0
3	1.0	180	7.0	24.8
3	1.0	1000	0.62	50.3
Corn, Sorghum and Wheat				
1	1.0	50	1.0	208.0
1	1.0	180	7.0	8.3
1	1.0	1000	0.62	16.8
Sugar beets				
1.6	1.0	50	1.0	332.8
1.6	1.0	180	7.0	13.2
1.6	1.0	1000	0.62	26.8

<sup>1</sup> The equation for the RQ is:  

$$\frac{\text{App. Rate (lbs a.i./A)} * (453,590 \text{ mg/lb}/43,560 \text{ ft}^2/\text{A})}{\text{LD}_{50} \text{ mg/kg} * \text{Weight of Animal (g)} * 1000 \text{ g/kg}}$$

The results indicate that for broadcast applications of granular products with no incorporation, avian acute high risk, restricted use, and endangered species levels of concern are all exceeded. The acute risk quotients for banded or in-furrow applications of granular products are tabulated below.

**Avian Acute Risk Quotients for Granular Products (Banded or In-furrow)**

Site/Method		Bird Type & Body Weight (grams)	% (dec.) of Phorate Unincorp.	Exposed mg/ft²	LD <sub>50</sub> (mg/kg)	Acute RQ¹ (LD <sub>50</sub> /Ft²)
Band Width	Oz.a.i./1000 ft of row					
Beans (soil band)						
0.17	1.875	Songbird (50)	0.01	3.13	1	62.6
0.17	1.875	Upland Gamebird (180)	0.01	3.13	7	2.5
0.17	1.875	Waterfowl (1000)	0.01	3.13	0.62	5.0
Corn (Banded over the Row at planting) Sorghum (soil band)						
0.6	1.2	Songbird (50)	0.15	8.50	1	170.0
0.6	1.2	Upland Gamebird (180)	0.15	8.50	7	6.7
0.6	1.2	Waterfowl (1000)	0.15	8.50	0.62	13.7
Cotton (soil sidedress treatment incorporated)						
0.5	2.4	Songbird (50)	0.15	20.41	1	408.2
0.5	2.4	Upland Gamebird (180)	0.15	20.41	7	16.2
0.5	2.4	Waterfowl (1000)	0.15	20.41	0.62	32.9
Filed Grown Lilies and Daffodils²						
1	4.7	Songbird (50)	0.01	1.33	1	26.6
1	4.7	Upland Gamebird (180)	0.01	1.33	7	1.1
1	4.7	Waterfowl (1000)	0.01	1.33	0.62	2.1
Peanuts (Soil band, at pegging)						
0.5	2.2	Songbird (50)	0.15	18.71	1	374.2
0.5	2.2	Upland Gamebird (180)	0.105	13.10	7	10.4
0.5	2.2	Waterfowl (1000)	0.15	18.71	0.62	30.2
Potato,White/Irish(Soil band)						

**Avian Acute Risk Quotients for Granular Products (Banded or In-furrow)**

Site/Method		Bird Type & Body Weight (grams)	% (dec.) of Phorate Unincorp.	Exposed mg/ft <sup>2</sup>	LD <sub>50</sub> (mg/kg)	Acute RQ <sup>1</sup> (LD <sub>50</sub> /Ft <sup>2</sup> )
Band Width	Oz.a.i./1000 ft of row					
0.6	3.5	Songbird (50)	0.15	24.81	1	496.2
0.6	3.5	Upland Gamebird (180)	0.15	24.81	7	19.7
0.6	3.5	Waterfowl (1000)	0.15	24.81	0.62	40.0
Radish (soil sidedress)						
0.17	1.25	Songbird (50)	0.15	31.27	1	625.4
0.17	1.25	Upland Gamebird (180)	0.15	31.27	7	24.8
0.17	1.25	Waterfowl (1000)	0.15	31.27	0.62	50.4
Soybeans (Soil band)						
0.6	1.8	Songbird (50)	0.15	12.76	1	255.2
0.6	1.8	Upland Gamebird (180)	0.15	12.76	7	10.1
0.6	1.8	Waterfowl (1000)	0.15	12.76	0.62	20.6
Sugar beets <sup>3</sup>						
0.8	0.9	Songbird (50)	0.15	4.78	1	95.6
0.8	0.9	Upland Gamebird (180)	0.15	4.78	7	3.8
0.8	0.9	Waterfowl (1000)	0.15	4.78	0.62	7.7
Sugarcane						
1	8.6	Songbird (50)	0.01	2.44	1	48.8
1	8.6	Upland Gamebird (180)	0.01	2.44	7	1.9
1	8.6	Waterfowl (1000)	0.01	2.44	0.62	3.9
Wheat (Soil in-furrow)						

**Avian Acute Risk Quotients for Granular Products (Banded or In-furrow)**

Site/Method		Bird Type & Body Weight (grams)	% (dec.) of Phorate Unincorp.	Exposed mg/ft <sup>2</sup>	LD <sub>50</sub> (mg/kg)	Acute RQ <sup>1</sup> (LD <sub>50</sub> /Ft <sup>2</sup> )
Band Width	Oz.a.i./1000 ft of row					
0.1	0.24	Songbird (50)	0.01	0.68	1	13.6
0.1	0.24	Upland Gamebird (180)	0.01	0.68	7	0.5
0.1	0.24	Waterfowl (1000)	0.01	0.68	0.62	1.1

<sup>1</sup> The equation for the RQ is:  

$$\frac{\text{oz. a.i. per 1000 ft.} * 28349 \text{ mg/oz} * \% \text{ Unincorporated} / \text{bandwidth (ft)} * 1000 \text{ ft}}{\text{LD50(mg/kg)} * \text{Weight of the Animal (g)} * 1000 \text{ (g/kg)}}$$

<sup>2</sup> The equation used to calculate the number of ounces per 1000 foot of row from 8 pounds per acre rate is shown below:

$$\text{Oz. a.i./1000 ft of row} * (43.56 \text{ feet/row spacing}) = \text{Lbs/A}$$

<sup>3</sup> This is a post-emergence application. This scenario assumes every row was two plants wide, the post-treatment was foliar, and the band extended from the outside of one plant to the outside edge of the other plant or a 14 inch band was used. Based on the label, this use was not soil incorporated.

The results indicate that for banded and in-furrow applications of granular products, avian acute high risk, restricted use, and endangered species levels of concern are all exceeded. The labeling carries the following warnings:

1. Beans - Do not place Phorate 20G granules in direct contact with seed at planting time.
2. Field corn, Sorghum, Soybeans, Sugar beets - Do not place Phorate 20G granules in direct contact with seed.
3. Do not apply in-furrow or allow to come in direct contact with the seed.

The phytotoxicity and label warnings would appear to rule out in-furrow as a risk reduction measure for most crops. Sugarcane and wheat appear to be the only two in-furrow crops at the present time. As shown in the table above sugarcane and wheat acute risk quotients for songbirds are 48.8 and 13.6, respectively. Wheat had the lowest RQ values among banded and in-furrow applications.

The table below, based on the Corn Cluster Analysis, compares phorate to four other corn OP pesticides, based on two indices, the estimated number of granules per square foot and the number of granules that a bird would need to ingest in order to obtain an amount of pesticide equal to the LD50.

### Estimated Number of Granules per Square Foot and Number of Granules per LD<sub>50</sub> for Corn at Plant

Pesticide	Formulation <sup>1</sup>	Granule Wt. <sup>1</sup>	Range of Granule Wt. <sup>1</sup>	App. Rate <sup>2</sup>	Band Width <sup>2</sup>	Percent Unincorporated <sup>5</sup>	Amount of Active Ingredient Exposed <sup>3</sup>	No. of Exposed Granules <sup>4</sup>	No. of Granules/LD <sub>50</sub> <sup>6,7</sup>
	(%AI/100)	(mg)	(mg)	(oz/1000 ft of row)	(ft)	(decimal)	(mg/ft <sup>2</sup> )	(/ft <sup>2</sup> )	(granules)
Chlorpyrifos	0.15	0.064	0.062-0.078	2.4	0.6	0.15	17.01	1,771.88	28.9
	0.15	0.064	0.062-0.078	2.4	0.1	0.01	6.80	708.33	28.9
Fonofos <sup>8</sup>	0.20	0.197	0.184-0.560	4.8	0.6	0.15	34.02	863.45	13.4
	0.10	0.197	0.184-0.560	4.8	0.6	0.15	34.02	1,726.90	26.7
<b>Phorate</b>	<b>0.20</b>	<b>0.085</b>	<b>0.067-0.143</b>	<b>1.2</b>	<b>0.6</b>	<b>0.15</b>	<b>8.50</b>	<b>500.00</b>	<b>3.1</b>
	<b>0.15</b>	<b>0.085</b>	<b>0.067-0.143</b>	<b>1.2</b>	<b>0.6</b>	<b>0.15</b>	<b>8.50</b>	<b>666.67</b>	<b>4.1</b>
Terbufos	0.20	0.85	0.056-0.080	1.2	0.6	0.15	8.50	50.00	4.6
	0.20	0.85	0.056-0.080	1.2	0.1	0.01	3.40	20.00	4.6
	0.15	0.066	0.056-0.080	1.2	0.6	0.15	8.50	858.59	79.7
	0.15	0.066	0.056-0.080	1.2	0.1	0.01	3.40	343.43	79.7

<sup>1</sup> Granule weights were obtained from Hill and Camardese, 1984, except the for terbufos 20% product which was provided by registrant.

<sup>2</sup> Rates from BEAD, (D.Brassard's June 25<sup>th</sup> memorandum "Transmittal of Corn Cluster Use Information for EFED Risk Assessment").

<sup>3</sup> Amount of pesticide exposed (mg/ft<sup>2</sup>) calculated with the following formula:

$$[(\text{oz a.i./1000 ft of row}) \times (28349 \text{ mg/oz conversion factor})] / [1000 \text{ ft of row} \times \text{bandwidth (ft)}] \times [0.15 \% \text{ unincorporated}]$$

<sup>4</sup> Number of exposed granules per square foot was determined by the following formula:

$$(\text{mg of a.i./ft}^2 \text{ exposed} / \text{percent a.i. of the product}) / \text{dividing the that by the weight of the granule.}$$

<sup>5</sup> Based on the rationale from the "Comparative Analysis of Acute Avian Risk from Granular Pesticides (1992) which indicates that 85% of the granules are incorporated.

<sup>6</sup> Number of granules per LD<sub>50</sub> was calculated with the following formula:

$$[(\text{LD}_{50} \times \text{bird weight})] / [(\% \text{a.i./100}) \times \text{granule weight}]$$

<sup>7</sup> The species with the lowest LD<sub>50</sub> was used in this calculation. They were: house sparrow, red-winged blackbird, and bobwhite quail for chlorpyrifos, fonofos, phorate, and terbufos, respectively. Unlike the other chemicals, for terbufos the only available LD<sub>50</sub> was for bobwhite quail. The smaller weight of passerine species increases the risk ratio. Therefore, to adjust for this, the weight of the red-winged blackbird was used with the bobwhite quail LD<sub>50</sub> value to estimate an LD<sub>50</sub> for red-winged blackbird.

<sup>8</sup> The weight of the 10% product was not available for fonofos. Hence the weight for the 20% product was used in these calculations.

**Avian chronic risk.** Risk quotients have not been developed for chronic/reproductive avian effects. However a variety of considerations suggest chronic risk, as discussed in greater detail in



the risk characterization below. In avian reproduction studies adverse effects were observed at low dietary concentrations (5 ppm in mallard and 60 ppm in quail).

**Risk to mammals.** Mammals may be exposed to granular pesticides ingesting granules when foraging for food, grooming, by walking on exposed granules or drinking contaminated water. The number of lethal doses ( $LD_{50}$ s) that are available within one square foot immediately after application ( $LD_{50}$ s/ft<sup>2</sup>) is used as the risk quotient for granular/bait products. Risk quotients are calculated for three separate weight classes of mammals: 1000 g, 35 g and 15 g.

The acute risk quotients for broadcast applications of granular products are tabulated below.

**Mammalian Risk Quotients for Granular Products (Broadcast, unincorporated) Based on a Rat  $LD_{50}$  of 1.4 mg/kg**

Site/Method Lbs(ai)/A Unincorporated	%(decimal) of Pesticide Left on the Surface	Body Weight (g)	$LD_{50}$ (mg/kg)	Acute RQ <sup>1</sup> ( $LD_{50}$ /ft <sup>2</sup> )
Corn and Hops				
3	1	15	1.4	1,485.71
3	1	35	1.4	636.73
3	1	1000	1.4	22.29
Corn, Sorghum and Wheat				
1	1	15	1.4	495.24
1	1	35	1.4	212.24
1	1	1000	1.4	7.43
Sugar beets				
1.5	1	15	1.4	742.86
1.5	1	35	1.4	318.37
1.5	1	1000	1.4	1.11

<sup>1</sup> The equation for the RQ is:

$$\frac{\text{App. Rate (lbs a.i./A)} * (453,590 \text{ mg/lb}/43,560 \text{ ft}^2/\text{A})}{LD_{50} \text{ mg/kg} * \text{Weight of Animal (g)} * 1000 \text{ g/kg}}$$

The results indicate that for broadcast, unincorporated granular products, acute high risk and restricted use LOCs are all exceeded. Also endangered species LOC has been exceeded for all weight classes. As with the avian analysis, the band width and application rates were selected to produce the highest EEC for each crop.

The acute risk quotients for banded or in-furrow applications of granular products are tabulated

below.

**Mammalian Acute Risk Quotients for Granular Products (Banded or In-furrow) Based on a rat LD<sub>50</sub> of 1.4 mg/kg**

Band Width (feet)	oz. a.i./1000 ft of row	Body Weight (kg)	% (decimal) of Unincorporated Pesticide	Exposed mg/ft <sup>2</sup>	Rat LD <sub>50</sub> (mg/kg)	Acute <sup>1</sup> RQ <sup>2</sup> (LD <sub>50</sub> /ft <sup>2</sup> )
Beans (Banded incorporated)						
0.17	1.875	15	0.01	3.13	1.4	149.0
0.17	1.875	35	0.01	3.13	1.4	63.9
0.17	1.875	1000	0.01	3.13	1.4	2.2
Corn and Sorghum						
0.6	1.2	15	0.15	8.50	1.4	404.8
0.6	1.2	35	0.15	8.50	1.4	173.5
0.6	1.2	1000	0.15	8.50	1.4	6.1
Cotton (Soil sidedress treatment, incorporated)						
0.5	2.4	15	0.15	20.41	1.4	971.9
0.5	2.4	35	0.15	20.41	1.4	416.5
0.5	2.4	1000	0.15	20.41	1.4	14.6
Field Grown Lilies and Daffodils						
1	4.7	15	0.01	1.33	1.4	63.3
1	4.7	35	0.01	1.33	1.4	27.1
1	4.7	1000	0.01	1.33	1.4	1.0
Peanuts (Soil band, at pegging)						
0.5	2.2	15	0.15	18.71	1.4	891.0
0.5	2.2	35	0.15	18.71	1.4	381.8
0.5	2.2	1000	0.15	18.71	1.4	13.4
Potato White/Irish (Soil band)						
0.6	3.45	15	0.15	24.45	1.4	1,164.3
0.6	3.45	35	0.15	24.45	1.4	499.0
0.6	3.45	1000	0.15	24.45	1.4	17.5
Radish (Soil sidedress)						
0.17	1.25	15	0.15	31.27	1.4	1,489.0
0.17	1.25	35	0.15	31.27	1.4	638.2

**Mammalian Acute Risk Quotients for Granular Products (Banded or In-furrow) Based on a rat LD<sub>50</sub> of 1.4 mg/kg**

Band Width (feet)	oz. a.i./1000 ft of row	Body Weight (kg)	% (decimal) of Unincorporated Pesticide	Exposed mg/ft <sup>2</sup>	Rat LD <sub>50</sub> (mg/kg)	Acute <sup>1</sup> RQ <sup>2</sup> (LD <sub>50</sub> /ft <sup>2</sup> )
0.17	1.25	1000	0.15	31.27	1.4	22.3
Soybeans (Soil band)						
0.6	1.8	15	0.15	12.76	1.4	607.6
0.6	1.8	35	0.15	12.76	1.4	260.4
0.6	1.8	1000	0.15	12.76	1.4	9.1
Sugar beets <sup>2</sup>						
0.8	0.9	15	0.15	4.78	1.4	227.6
0.8	0.9	35	0.15	4.78	1.4	97.6
0.8	0.9	1000	0.15	4.78	1.4	3.4
Sugarcane						
1	8.6	15	0.01	2.44	1.4	116.2
1	8.6	35	0.01	2.44	1.4	49.8
1	8.6	1000	0.01	2.44	1.4	1.7
Wheat (Soil in-furrow)						
0.1	0.24	15	0.01	0.68	1.4	32.4
0.1	0.24	35	0.01	0.68	1.4	13.9
0.1	0.24	1000	0.01	0.68	1.4	0.5

<sup>1</sup> The equation for the RQ is:  $\frac{\text{oz. a.i. per 1000 ft.} \times 28349 \text{ mg/oz} \times \% \text{ Unincorporated/bandwidth (ft)} \times 1000 \text{ ft}}{\text{LD}_{50}(\text{mg/kg}) \times \text{Weight of the Animal (g)} \times 1000 \text{ g/kg}}$

<sup>2</sup> This is a post-emergence application. This scenario assumes every row was two plants wide, the post-treatment was foliar, and the band extended from the outside of one plant to the outside edge of the other plant or a 14 inch band was used. Based on the label this use was not soil incorporated.

**Insects.** Currently, EFED has no procedure for assessing risk to nontarget insects. Results of acceptable studies are used for recommending appropriate label precautions. EFED assumes that for granular formulations the hazard is minimal to bees.

### (3) Aquatic Level of Concern Evaluation

Levels of concern for impacts on aquatic organisms and ecosystems are based on toxicity results from guideline studies, and Tier II estimated environmental concentrations (EECs). The

calculation of EECs is described in detail in the section "Water Resources" above, which also displays all of the EEC values calculated. The EEC in each category (maximum, 4-day, etc.) is expected to be equaled or exceed once every ten years, that is it has a 1 in 10 year return frequency.

EECs have been calculated in two ways representing (1) parent phorate only and (2) the combined concentration of parent phorate, phorate sulfoxide, and phorate sulfone ("total OP residue"). The same exposure estimates have been used for estuarine/marine animals as for freshwater animals. The tables on the following pages display four sets of risk quotients:

- concentration of parent phorate relative to toxicity to freshwater (FW) animals;
- concentration of total OP residue relative to toxicity to freshwater animals;
- concentration of parent phorate relative to toxicity for marine/estuarine animals;
- concentration of total OP residue relative to toxicity for marine/estuarine animals.

At this time, toxicity information is not available for phorate metabolites. Risk quotients for total OP residue have been calculated using the available toxicity measurements, which are for parent phorate, assuming equal toxicity of parent phorate and phorate metabolites.

In addition to the scenarios evaluated in the Water Resources Assessment, based on use information from American Cyanamid, an RQ has been calculated for lilies and daffodils, with an application rate of 8 lb ai/A, by multiplying the RQs for cotton by the ratio of application rates 8/1.6.

For the potato scenario with in-furrow application, the modeling results suggest negligible exposure. However, EFED is not confident that the incorporation options in the current version of the PRZM model adequately represent availability of pesticide for in-furrow applications and therefore is not confident that exposures would be negligible for in-furrow applications to potatoes. For the scenarios other than the potato scenario, all acute risk quotients exceed high risk criteria. Most of the chronic RQs exceed levels of concern: The exception is the FW fish chronic RQ of 0.08.

The RQs for estuarine/marine animals are higher than the RQs for freshwater animals for each of the four aquatic toxicity endpoints (fish acute, fish chronic, invertebrate acute, invertebrate chronic), reflecting the higher toxicity observed for each category.

#### **(4) Exposure and Risk to Nontarget Plants**

Plant testing is not required for granular pesticides or insecticides.

**Risk quotients for freshwater fish and invertebrates based on estimated concentration of parent Phorate**

Crop	Application rate, procedure	Estimated Environmental Concentration (EEC, ppb)			Risk Quotients by Crop, rate etc.			
					fish, acute	fish, chronic	invert., acute	invert., chronic
					<u>Toxic concentration (LC50 or NOAEC, ppb)<sup>1</sup></u>			
					1	2.6	0.6	0.21
					<u>Exposure column for EEC</u>			
		peak	21 day	60 day	peak	60 day	peak	21 day
Sweet Corn	T-banded at 1.3 lb ai/A	21.3	3.3	1.2	21	0.46	36	16
Peanuts	1.64 lb ai/A at plant in- furrow, 2.9 lbs a/A side dressed 90 days prior to harvest	18.1	2	0.7	18	0.27	30	10
Cotton	In-furrow at 1.6 lb ai/A	23.1	3.9	1	23	0.54	39	19
Potatoes	Idaho, in-furrow at 3.5 lb ai/A	[Estimated exposure = zero <sup>2</sup> ]						
Field corn	T-banded at 1.3 lb ai/A	4.6	0.7	0.2	4.6	0.08	7.7	3.3
Grain sorghum	T-banded at 2 lb ai/A	7.5	1.2	0.4	7.5	0.15	13	5.7
Lilies & Daffodils	8 lb ai/A	115.5	19.5	7	116	2.7	193	93

<sup>1</sup> Toxicity Measurements: Acute, FW fish: LC50 for bluegill sunfish; Chronic, FW fish: NOEC for rainbow trout;

Acute, FW invert.: LC50 for *Gammarus* (Crustacea); Chronic, FW invert: NOEC for *Daphnia* (Crustacea)

<sup>2</sup> See discussion of model limitations in the environmental fate assessment. Incorporation options in the current version of the PRZM model may not adequately represent the availability of the chemical for runoff.

**Risk quotients for freshwater fish and invertebrates based on estimated combined concentration of parent Phorate, Phorate sulfone, and Phorate sulfoxide**

Crop	Application rate, procedure	Estimated Environmental Concentration (EEC, ppb)			Risk Quotients by Crop, rate etc.			
					fish, acute	fish, chronic	invert., acute	invert., chronic
		Toxic concentration (LC50 or NOAEC, ppb) <sup>1</sup>						
		1	2.6	0.6	0.21			
		Exposure column for EEC						
peak	21 day	60 day	peak	60 day	peak	21 day		
Sweet Corn	T-banded at 1.3 lb ai/A	26.9	8.2	5.9	27	2.3	45	39
Peanuts	1.64 lb ai/A at plant in-furrow, 2.9 lbs a/A side dressed 90 days prior to harvest	25.2	8.8	4.7	25	1.8	42	42
Cotton	In-furrow at 1.6 lb ai/A	27.6	12.4	8.2	28	3.2	46	59
Potatoes	Idaho, in-furrow at 3.5 lb ai/A	[Estimated exposure = zero <sup>2</sup> ]						
Field corn	T-banded at 1.3 lb ai/A	7.7	3.9	2.5	7.7	1.0	13	19
Grain sorghum	T-banded at 2 lb ai/A	12.7	7.1	4.2	13	1.6	21	34
Lilies & Daffodils	8 lb ai/A	138	62	41	138	15.8	230	295

<sup>1</sup> Toxicity Measurements: Acute, FW fish: LC50 for bluegill sunfish; Chronic, FW fish: NOEC for rainbow trout;

Acute, FW invert.: LC50 for *Gammarus* (Crustacea); Chronic, FW invert: NOEC for *Daphnia* (Crustacea)

<sup>2</sup> See discussion of model limitations in the environmental fate assessment. Incorporation options in the current version of the PRZM model may not adequately represent the availability of the chemical for runoff.

**Risk quotients for marine/estuarine fish and invertebrates based on estimated concentration of parent Phorate**

Crop	Application rate, procedure	Estimated Environmental Concentration (EEC, ppb)			Risk Quotients by Crop, rate etc.			
					fish, acute	fish, chronic	invert., acute	invert., chronic
					<u>Toxic concentration (LC50 or NOAEC, ppb)<sup>1</sup></u>			
		peak	21 day	60 day	<u>Exposure column for EEC</u>			
					peak	60 day	peak	21 day
Sweet Corn	T-banded at 1.3 lb ai/A	21.3	3.3	1.2	59	34	194	623
Peanuts	1.64 lb ai/A at plant in-furrow, 2.9 lbs a/A side dressed 90 days prior to harvest	18.1	2	0.7	50	21	165	377
Cotton	In-furrow at 1.6 lb ai/A	23.1	3.9	1	64	41	210	736
Potatoes	Idaho, in-furrow at 3.5 lb ai/A	[Estimated exposure = zero <sup>2</sup> ]						
Field corn	T-banded at 1.3 lb ai/A	4.6	0.7	0.2	13	7.3	42	132
Grain sorghum	T-banded at 2 lb ai/A	7.5	1.2	0.4	21	13	68	226
Lilies and Daffodils	8 lb ai/A	115.5	19.5	7	321	72.9	1050	3679

<sup>1</sup>Toxicity Measurements: Acute, fish: EC50 for killifish; Chronic, fish: NOEC for sheepshead minnow; Acute, invert.: EC50 for pink shrimp; Chronic, invert: NOEC for mysid (Crustacea)

<sup>2</sup> See discussion of model limitations in the environmental fate assessment. Incorporation options in the current version of the PRZM model may not adequately represent the availability of the chemical for runoff.



**Risk quotients for marine/estuarine fish and invertebrates based on estimated combined concentration of parent Phorate, Phorate sulfone, and Phorate sulfoxide**

Crop	Application rate, procedure	Estimated Environmental Concentration (EEC, ppb)			Risk Quotients by Crop, rate etc.			
					fish, acute	fish, chronic	invert., acute	invert., chronic
		<u>Toxic concentration (LC50 or NOAEC, ppb)<sup>1</sup></u>						
		0.36                      0.096                      0.11                      0.0053						
		<u>Exposure column for EEC</u>						
peak	21 day	60 day	peak	60 day	peak	21 day		
Sweet Corn	T-banded at 1.3 lb ai/A	26.9	8.2	5.9	75	85	245	1547
Peanuts	1.64 lb ai/A at plant in-furrow, 2.9 lbs a/A side dressed 90 days prior to harvest	25.2	8.8	4.7	70	92	229	1660
Cotton	In-furrow at 1.6 lb ai/A	27.6	12.4	8	77	129	251	2340
Potatoes	Idaho, in-furrow at 3.5 lb ai/A	[Estimated exposure = zero <sup>2</sup> ]						
Field corn	T-banded at 1.3 lb ai/A	7.7	3.9	2.5	21	41	70	736
Grain sorghum	T-banded at 2 lb ai/A	12.7	7.1	4.2	35	74	115	1340
Lilies & Daffodils	8 lb ai/A	138	62	41	383	646	1255	11698

<sup>1</sup>Toxicity Measurements: Acute, fish: EC50 for killifish; Chronic, fish: NOEC for sheepshead minnow;

Acute, invert.: EC50 for pink shrimp; Chronic, invert: NOEC for mysid (Crustacea)

<sup>2</sup> See discussion of model limitations in the environmental fate assessment. Incorporation options in the current version of the PRZM model may not adequately represent the availability of the chemical for runoff.

## **(5) Endangered Species**

All terrestrial and aquatic endangered species LOCs are exceeded for phorate, with the exception of in-furrow potatoes. (As discussed previously, EFED is not confident that exposure would be negligible with in-furrow potatoes.)

The Endangered Species Protection Program is expected to become final in the future. Limitations in the use required to protect endangered and threatened species, but these limitations have not been defined and may be EPA anticipates that a consultation with the Fish and Wildlife Service will be conducted in accordance with the approach described in the Program. After completion of consultation, registrants will be informed if any requirements are necessary. Such modifications would most likely consist of the generic label statement referring pesticide contained in county Bulletins.